4.12 Validation and Verification

Validation and Verification is the System Engineering (SE) process that confirms that system requirements are correct and satisfied (Figure 4.12-1). The Validation process confirms that the right system is being built (i.e., that the system requirements are unambiguous, correct, complete, consistent, operationally and technically feasible, and verifiable). The Verification process ensures that the design solution has met the system requirements and that the system is ready for use in the operational environment for which it is intended. This section describes the Validation and Verification process, including the inputs, outputs, and specific tasks of Validation and Verification.

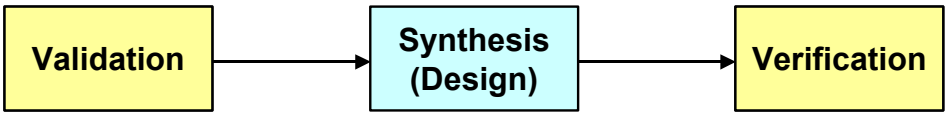


Figure 4.12-1. Validation and Verification's Role in System Development Process

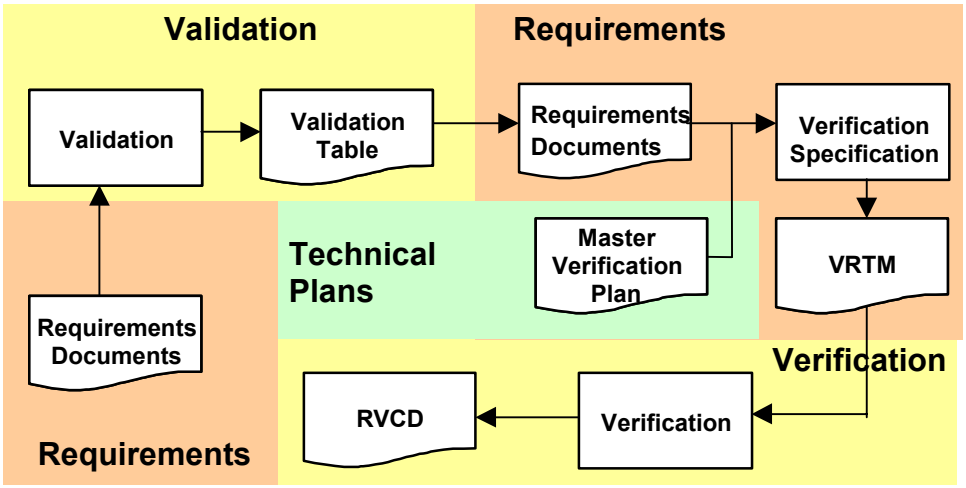


Figure 4.12-2. Validation and Verification Activities

The Validation and Verification activities, illustrated in Figure 4.12-2, are summarized below:

- Requirements feed Validation. During Validation activities, a Validation Table is developed that is included in a Validation Report when completed. The Validation Report is an input to the requirements document. The Validation Table becomes the basis for later Verification activities.
- At the same time, work begins on Verification planning and is documented in a "living" joint SE and Test and Evaluation (T&E) Master Verification Plan (MVP)(described and developed under Integrated Technical Planning (Section 4.2)).

- After Verification planning is completed, a specification/approach for verifying each requirement is developed in Requirements Management (Section 4.3) and documented for each requirement in the Validation Table. This update to the Validation Table transforms it to a Verification Requirements Traceability Matrix (VRTM), which becomes the foundation for the next activity and is included in the MVP as an update.
- After Verification activities are performed, the VRTM is updated with evidence of completion of activities. Using the updated VRTM, the Verification team develops the Requirements Verification Compliance Document (RVCD) to record completion of the Verification effort. The RVCD also identifies system compliance or noncompliance with the set of requirements used for the Verification activities. Program management uses this information for the Risk Management process (Section 4.10).

4.12.1 Validation

As stated earlier, the Validation process (Figure 4.12-3) confirms that the right system is being built (i.e., that the system requirements are unambiguous, correct, complete, consistent, operationally and technically feasible, and verifiable). The process is conducted in order to demonstrate that the requirements for a system are clearly understood and that it is possible to satisfy the requirements through design work using available state-of-the-art technology, funding, and schedule.

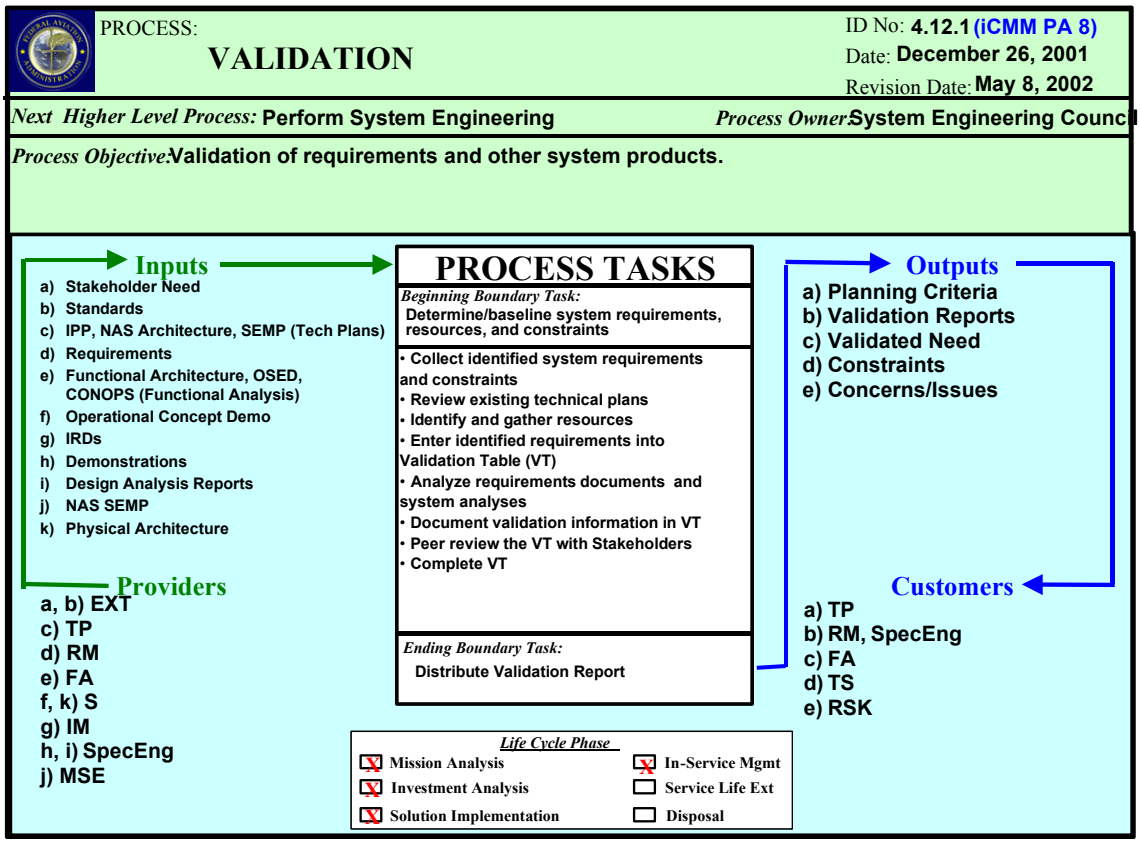


Figure 4.12-3. Validation Process-Based Management Chart

The Validation process is repeated incrementally at all stages of requirements development to ensure that the design at all levels is consistent with the intended mission. Validation follows the development of system requirements. Since these requirements are hierarchical in nature and developed in increasing detail as the lifecycle progresses, Validation is a staged process (Figure 4.12-4). Thus, as each level of requirements is developed, the requirements at that level undergo Validation, after which each validated requirement undergoes Verification.

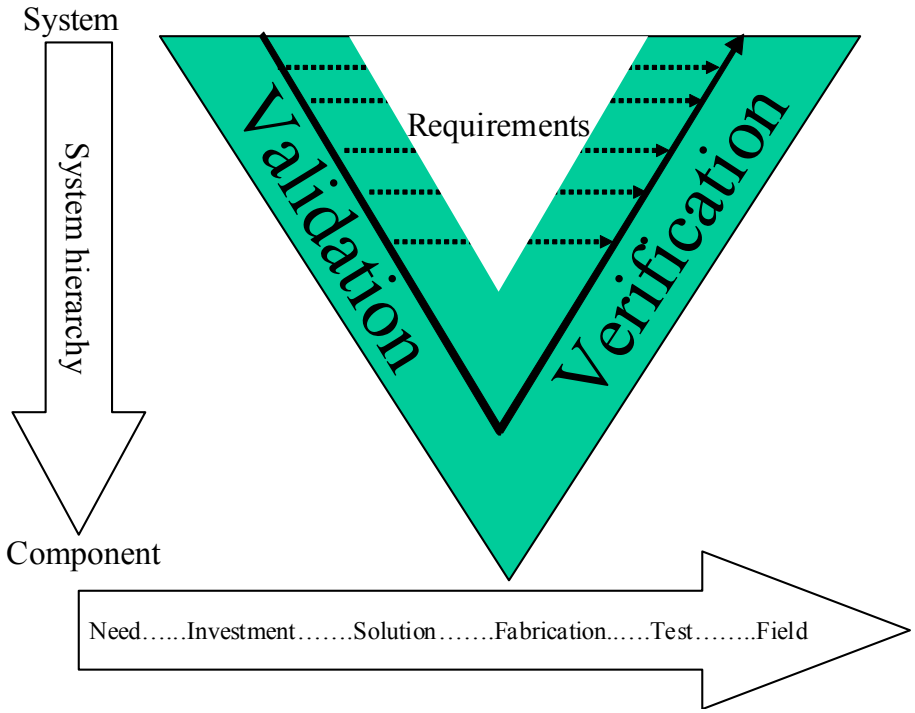


Figure 4.12-4. System Engineering "V" Diagram

A large part of this SE activity is challenging the requirements need and the requirements' associated values before development of solutions. This activity helps to ensure that an economy of effort exists on the project and that resources are not wasted on developing solutions for unnecessary requirements. At each stage, the Validation process provides increasing confidence of the correctness and completeness of system requirements.

4.12.1.1 Definition of Validation

There are multiple definitions of the Validation process, but, for the purposes of this manual and the Federal Aviation Administration (FAA), the accepted definition of the Validation process is:

> *"the determination that the requirements for a product are sufficiently correct and complete." (SAE ARP 4761, 1996)*

4.12.1.2 Objective of Validation

The primary objective of the Validation process is to ensure that requirements are correct and complete. In addition, the Validation process ensures that requirements defined for a system

are consistent with the characteristics listed in Requirements Management (Section 4.3). Successful Validation confirms that the identified requirements are justified, relevant, and logically correct in terms of the customer's needs and operating environment. In addition, the Validation process also ensures that the identified set of requirements is complete (i.e., containing all essential elements). To achieve Validation's objective, Validation activities are performed as early as possible in the development phase after requirements are identified; thus, Validation follows requirements development and precedes design solution.

The Validation process is conducted in order to find and correct poor requirements, which stem from three sources:

- Ambiguous requirements statements
- Incorrect (including unnecessary) requirements statements
- Incomplete (or omitted) requirements statements

4.12.1.3 Interfaces With Other System Engineering Processes

The SE elements that interface with the Validation process appear in Figure 4.12-5 and are described in "Inputs to Validation" (Paragraph 4.12.1.4).

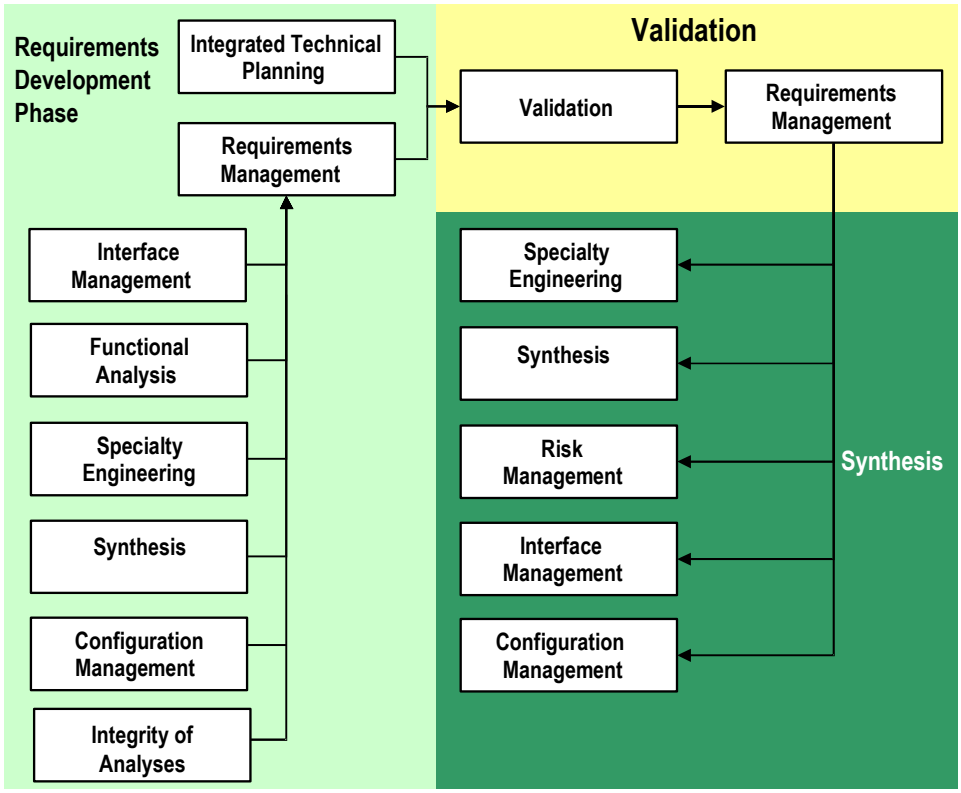


Figure 4.12-5. How Validation Interfaces with Other System Engineering Processes

4.12.1.4 Inputs to Validation

The inputs to the Validation process include:

- Stakeholder Needs
- Standards
- Technical Plans (Integrated Program Plan (IPP), National Airspace System (NAS) Architecture, and program System Engineering Management Plan (SEMP))
- Requirements
- Functional Analysis (Functional Architecture, Operational Services and Environmental Description (OSED), and Concept of Operations (CONOPS))
- Operational Concept Demonstrations
- Interface Requirements Document(s) (IRD)
- Demonstrations
- Design Analysis Reports (DAR)
- NAS SEMP
- Physical Architecture

4.12.1.4.1 Stakeholder Needs

The original Stakeholder Need generated from a NAS stakeholder (or stakeholders) to identify a capability shortfall requires Validation. Once a Stakeholder Need is validated, SE continues to ultimately provide a balanced solution to the need.

4.12.1.4.2 Standards

Industry and government standards are additional inputs to the Validation process. These documents often contain information required to validate the Requirements of a system not found in higher-level requirements documents. They include publications and standards from the Society of Automotive Engineers (SAE) and/or the International Organization of Standards (ISO), as well as U.S. Government advisory circulars and FAA regulations.

4.12.1.4.3 Technical Plans

Technical plans are an output of the Integrated Technical Planning process (Section 4.2). These plans define the program's tailored tasks for conducting Validation and Verification for a specific program. The IPP lays out the overall program and details the program's planned activities. The FAA Acquisition System Toolset (FAST) (http://fast.faa.gov/ams/ippdesc.htm) supplies a complete description of the IPP, and Integrated Technical Planning discusses SE's role in producing the IPP. In addition to the IPP, the program's SEMP and the NAS Architecture shall be used as inputs to the Validation process. The NAS Architecture is considered a part of the technical plans package in that it defines the FAA framework for future systems in the NAS. This architecture is a useful resource for validating the Requirements for systems developed for NAS Modernization.

4.12.1.4.4 Requirements

Requirements documents are outputs from the Requirements Management process (Section 4.3). These documents include the initial Requirements Document (iRD) and final

Requirements Documents (fRD) (as they become available), as well as supporting documents such as:

- Program and technical requirements
- Customer operational requirements, including the Mission Need Statement (MNS)
- Regulatory, agency, and statutory requirements

The Requirements are classified under several categories described in “Requirements Category” (Paragraph 4.3.3.2.1.4.3). The two major categories are (1) program requirements and (2) technical requirements. Program requirements are imposed on vendors through contracts, not specifications. Technical requirements apply to the system or service under acquisition, and they are described in requirements documents, system specifications, and IRDs.

4.12.1.4.5 Functional Analysis

The Functional Analysis process (Section 4.4) is an SE tool that provides a functional (what the system does, not how) description of a system that becomes a framework for synthesis and requirements development. It is recommended that the output of this process be used to validate Requirements. The outputs of this process are:

- Functional Architecture(s)
- OSED; RTCA/DO-264, Appendix C, System Handbook (SSH), Sections 4.1.1 and 3.8
- CONOPS

4.12.1.4.6 Operational Concept Demonstrations

Operational Concept Demonstrations (“Demonstrations” (Paragraph 4.8.0.4.8)) are conducted to determine and validate high-risk Requirements associated with an unvalidated CONOPS.

4.12.1.4.7 Interface Requirements Documents

IRDs are another example of system design information. These documents, which are outputs of the Interface Management process (Section 4.7), provide a deeper understanding of the underlying interfaces, functions, and reasons for the Requirements. These descriptions include the system-level interface definitions. Part of the Validation of a system is the assurance that the Requirements for these interfaces are correct.

4.12.1.4.8 Demonstrations

Specialty engineers, as deemed necessary, often conduct Demonstrations (“Demonstrations” (Paragraph 4.8.0.4.8)) as part of analysis efforts (e.g., maintainability demonstration or human factors demonstrations). These Demonstrations provide useful feedback on the effectiveness and value of various design alternatives. Additionally, the Demonstrations may generate information for use while validating Requirements are being validated.

4.12.1.4.9 Design Analysis Reports

DARs are outputs of the Specialty Engineering process (Section 4.8). These reports document the results of the Specialty Engineering analyses, which may contribute to the identification, Validation, and Verification of Requirements.

4.12.1.4.10 National Airspace System System Engineering Management Plan

The NAS SEMP defines the overall plan for SE in the Acquisition Management System (AMS). This plan details *who, what, when,* and *why* SE tasks are performed in support of AMS programs. The System Engineering Manual (SEM), on the other hand, defines how the SE processes are performed.

4.12.1.4.11 Physical Architecture

The Physical Architecture is essentially the engineering design of the system that is produced via the Synthesis process (Section 4.5). This information may vary in detail, depending on the phase of the program. This input is essential so that the persons responsible for the Validation process understand the product Requirements and configuration (if available). Information includes:

- Drawings (if updating current systems, and if they exist in the Validation phase)
- Design descriptions
- System descriptions

4.12.1.5 The Validation Process

The following sections describe the purpose, general outcomes/expectations, and tasks of the Validation process.

4.12.1.5.1 Validation Process Purpose

Validation is primarily performed to ensure the correctness and completeness of the requirements that define a system. ARP 4754, Paragraph 7.1, defines correctness and completeness as follows:

- Correctness of a requirements statement means the absence of ambiguity or error in its attributes
- Completeness of a requirements statement means that no attributes have been omitted and that those stated are essential

System requirements are analyzed to ensure that the defined set of Requirements is consistent with the operational need defined in the CONOPS, Specialty Engineering analyses, and MNS. The Validation process is conducted to provide objective evidence that the services provided by the system, as defined in the requirements document, comply with the Stakeholder Needs, as defined in the analyses, CONOPS, and MNS. When variances are identified, they are recorded and used to guide corrective actions. Because Validation is a comparative assessment of Requirements against needs, it also results in confirmation that Stakeholder Needs are correctly identified and requested. Stakeholders normally ratify Validation of Requirements at the system level.

"Task 5: Analyze Requirements Documents and System Analyses" (Paragraph 4.12.1.5.3.5) describes the desired attributes of Requirements. The Requirements Management (Section 4.3) also describes the desired attributes of individual Requirements.

4.12.1.5.2 Validation Process Objectives

The general objectives of the Validation process include:

- Development of the Validation Table and inclusion of the Validation Table in a Validation Report
- Appending to or referencing by the existing requirements documents of the Validation Report
- Confirmation that the system services required by stakeholders are properly documented in the Requirements
- Confirmation that the stakeholder requirements faithfully describe the required system services
- Reporting of nonconformance, which is used to guide corrective actions
- Traceability of all requirements to higher-level Requirements
- Documentation of the program's concerns/issues and constraints

4.12.1.5.3 Validation Process Tasks

All Requirements in all categories are required to be validated. In general, the Validation of higher-level Requirements serves as a basis of Validation for lower-level Requirements. The tasks involved in the Validation process are conducted in three phases: planning, evaluation, and documentation. The recommended process tasks for validating Requirements are shown in Figures 4.12-3 and 4.12-6 and are described in the following paragraphs.

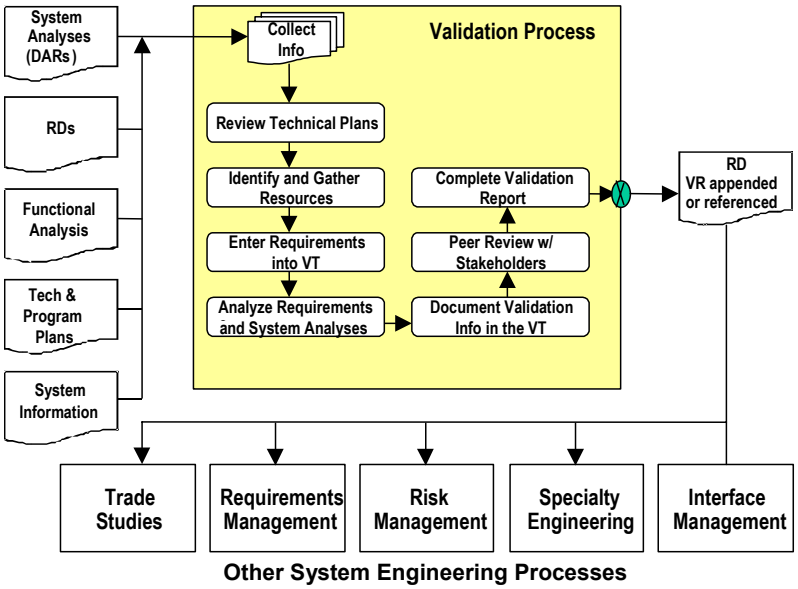


Figure 4.12-6. Overall Validation Process and Outputs

4.12.1.5.3.1 Task 1: Collect Identified System Requirements and Constraints

The initial step in the Validation process is to accept the set of Requirements to be validated from the Requirements Management process (Section 4.3). In addition, the information required for Validation is gathered, which documents the baseline system requirements, resources, and constraints. These documents are described in "Inputs to Validation" (Paragraph 4.12.1.4) and include the requirements documents, technical plans, and system description information.

4.12.1.5.3.2 Task 2: Review the Existing Technical Plans

The next step is to review the program and acquisition plans, such as the IPP and the MVP, if it exists. These plans include the Validation tasks to be performed; allocation of responsibility to organizations; schedule; and costs. The objective is to define the strategy for validating the system's services in its operational environment and achieving customer satisfaction in accordance with these plans. This strategy depends on the lifecycle stage (e.g., whether a model, prototype, or actual product is being verified); on risks (e.g., novelty, safety, technical, and commercial criticality issues); and on the agreement and organizational constraints of the stakeholder requirements. It is required that, where appropriate, Validation steps (e.g., various operational states, scenarios, and missions) be defined that progressively build confidence in compliance of the installed system and assist diagnosis of any noncompliance.

NOTE

Where Stakeholder Needs are unable to be specified in advance or change frequently, repeated Validation of (often rapidly developed) increments in system evolution may be employed to refine stakeholder requirements and mitigate risks in the correct identification of need. For example, ISO 13407 describes an iterative lifecycle that involves users.

4.12.1.5.3.3 Task 3: Identify and Gather Resources

At this stage, the Validation resources are formed from the appropriate SE resources. These resources include tools, information, and organizations, including the execution teams, stakeholders, and SE.

4.12.1.5.3.4 Task 4: Enter the Identified Requirements Into a Validation Table

This step involves entering or copying the Requirements from the requirements document into a table, spreadsheet, database, or other SE tool appropriate to managing the Validation of Requirements. Table 4.12-1 shows an example of a typical Validation Table. Each Requirement and specification that defines a system, at all levels, shall be listed in a Validation Table.

Table 4.12-1. Example Validation Table

(PUI)	Requirement	Requirements Document or specification?	Validated? Y/N	Source(s)	Location in Source	Conformance information	Corrective Action Owner
Program Unique Identifier. Enter a unique number here to ID the Requirement. This ID is the paragraph number from the requirements document.	Copy the Requirement here verbatim from the requirements document and specification.	Identify where the Requirement is found.	Indicate whether the Requirement was validated.	…of Validation. Explain the source of the Validation, (e.g., a safety analysis or other means).	Where specifically in the source the Requirement is validated.	State conformance basis. If nonconformance is found, state recommended or required corrective action.	Organization or individual that owns the conformance or corrective action
3.2.1.1.1	The ADS-B system shall continue to operate normally in icing conditions up to heavy icing, as defined in 14 CFR FAR 25. (example only)	iRD	YES or check	IRD, ADS-B, OSA	IRD: Paragraph 3.2.1.1.1 OSA: Paragraph 2.5.5	System safety confirms that icing is expected in the operational environment description.	AND-710

4.12.1.5.3.5 Task 5: Analyze Requirements Documents and System Analyses

During Task 5, a review of the existing requirements documents is performed. Also during this task, the set of Requirements that is being evaluated for validity is compared to the existing higher-level requirements documents. The Validation of higher-level Requirements may serve as the basis for Validation of lower-level Requirements, if traceability is demonstrable. If the existence of a validated Requirement in a higher-level requirements document is shown, then lower-level Requirements that are traced from the validated Requirement may be partially validated on this basis. The lower-level Requirements still need to meet the characteristics listed in "Validation Process Purpose" (Paragraph 4.12.1.5.1). For example, assume that a Requirement is listed in a validated MNS and the current task is to validate the functional requirements. If the functional requirement is traceable to a Functional Architecture based on the MNS (higher level), then the functional requirement (lower level) is considered partially validated by virtue of this traceability. However, the functional requirement in this example still requires evaluation of the characteristics listed in "Validation Process Purpose." Once complete, the Requirement is considered validated.

If a Requirement is not contained in a higher-level requirements document, then it is evaluated by detailed review of Functional Analyses, results of prototype evaluations, Specialty Engineering analyses in documented DARs, specified design guides, CONOPS, the NAS Architecture, and other industry and government standards that describe the system and assess the system's needs and capability shortfalls. These documents often contain information needed to validate Requirements not found in higher-level requirements documents. In these

documents, the Verification team looks for candidate requirements, recommendations, functional requirements, and other information that confirm the need for the stated Requirement.

The following Validation principles shall be employed when performing Validation activities:

- Ensure that stakeholders and testers are an integral part of the Validation process
- Perform research and analysis to find information and/or related Requirements that confirm the need for a particular Requirement (e.g., a set of related Requirements may confirm the need and validity of a derived Requirement)
- Note Requirements that are unable to be confirmed; these Requirements are noted as nonconforming[1] and evaluated for removal in the Requirements Management process (Section 4.3)
- Conduct Validation activities to detect (in the system or services) the existence of random and systematic nonconformance to stakeholder requirements
- Ensure that the Validation process is undertaken in a manner consistent with defined and documented organizational practices to minimize uncertainty in the replication of Validation actions, conditions, and outcomes
- Maintain objective and authenticated records of Validation actions and outcomes
- Conduct fault resolution of a nonconformance in the Requirements Management process to a level of resolution consistent with cost-effective remedial action, including revalidating following defect correction and/or organizational quality improvement actions
- Conduct Validation activities to determine the correctness and completeness of the Requirements

When Validation is performed, the following correctness and completeness checks (may be tailored by expansion) shall be completed at each level of the Requirements hierarchy:

Correctness

1. Requirements correctly stated:
    - What is required (design independent)
    - Unambiguous
    - Statements lead to appropriate design
    - Achievable with current or emerging technology
    - Requirement is verifiable
    - Stated for appropriate environmental conditions (ambient and operational)

[1] Nonconformance means that a needed Requirement is missing, or an existing Requirement is unable to be validated. In accordance with agreement terms or organizational objectives, Validation is conducted to isolate the part of the system that gives rise to a nonconformance, which may result in the need for corrective action and/or changes in quality management policy. “Objective of Validation” (Paragraph 4.12.1.2) discusses the sources of nonconformance.

- Stated for normal and abnormal operations
- Derived Requirements supported by analyses
- Each Requirement has an identified source

2. Requirements correctly reflect the analyses:
   - Appropriate analyses completed correctly
   - System hazards correctly identified and classified according to risk
   - System characteristics in DARs correctly identified and classified
   - Reliability, availability, fault detection, and tolerances identified
3. Functions correctly identified:
   - Requirements based on functions
   - Functions significant to Requirements
   - Documented
   - Traced to higher functions
   - Constrained by higher-level Requirements

Completeness

1. Requirements traceable to an identified source:
   - Functional Analysis
   - Higher-level requirements documents
   - Safety assessments
   - Reliability, maintainability, and availability (RMA) analyses (Failure Modes and Effects Analysis (FMEA), Failure Modes and Effects Criticality Analysis (FMECA))
   - Requirements identified in DARs (Specialty Engineering" (Paragraph 4.12.2.3.4))
   - Derived Requirements
   - Regulations, standards, or statutory requirements
   - OSED
   - Integration requirements
2. Constraints defined, substantiated, and addressed:
   - State of the art
   - Safety
   - Environment
   - Industry and FAA standards
   - Specify system implementation

3. System implementation specified:
    - Functional analysis completed
    - Requirements allocated to systems
    - Architecture defined at each functional level
    - Interfaces (internal and external) defined—human, hardware, software, physical, functional, procedural, and environmental (ambient and operational)
4. All prohibited behaviors and characteristics explicitly stated
5. All technical performance measures explicitly stated

4.12.1.5.3.6 Task 6: Document the Validation Information in the Validation Table

During this task, Validation data is collected, classified, and collated in the Validation Table described in "Task 4: Enter the Identified Requirements Into a Validation Table" (Paragraph 4.12.1.5.3.4) and in accordance with criteria defined in the program and acquisition plans. This process categorizes conforming and nonconforming Requirements according to their source and corrective action owner. The Validation data is then analyzed to detect essential features, such as trends and patterns of failure, evidence of systemic failings, and emerging threats to system services.

4.12.1.5.3.7 Task 7: Peer Review the Validation Table With Stakeholders

During this task, the stakeholders of the system's Requirements are identified. Once the Validation Table is filled, the stakeholders review it. Stakeholder comments are incorporated into the table, and the table is finalized.

4.12.1.5.3.8 Task 8: Document the Requirements Validation Analysis in the Validation Table and Include the Validation Table in a Validation Report

The results of the Validation analysis are documented in the Validation Table, and the Validation Table is included in a Validation Report. The Validation Report is transmitted to Requirements Management (Section 4.3). This report is appended to or referenced by the requirements document.

The Validation Report summarizes the Validation effort and results and communicates the Validation Table to other SE processes. The following format shall be used as a guide for the contents and organization of a Validation Report.

Validation Report format:

I. Summary of Validation efforts and results
    a. Summarize the Validation results when locating conforming and nonconforming Requirements
II. System and program description
III. Methodology used

IV. Unvalidated Requirements

a. List of nonconforming Requirements

b. Recommendations for correction of nonconforming Requirements

V. Validation Table

VI. Discussion of trends and patterns of failure, evidence of systemic failings, and emerging threats to system services.

4.12.1.6 Tailoring of Validation Activities

Tailoring of a program's Validation activities is limited to the following:

- The specific means of Validation may include the techniques and tools employed and described in SAE ARP 4754, Section 7.7, if desired by the program
- The specific contents of the Validation Report may be tailored to include additional information as specified in "Task 8: Document the Requirements Validation Analysis in the Validation Table and Include the Validation Table in a Validation Report" (Paragraph 4.12.1.5.3.8)

4.12.2 Verification

The Verification process ensures that the design solution has met the system requirements and that the system is ready for use in the operational environment for which it is intended. This description means that a verified system is able to demonstrate (show evidence) that it complies with mission need; functional, performance, allocated, derived, and interface requirements; and design and allocated constraints that achieve stakeholder needs. The Verification process (Figures 4.12-4 and 4.12-7) supports system evolution at all levels of the system's lifecycle, from concept to advanced studies and preliminary analyses to design and development, culminating in the production, product acceptance, operational, and disposal phases.

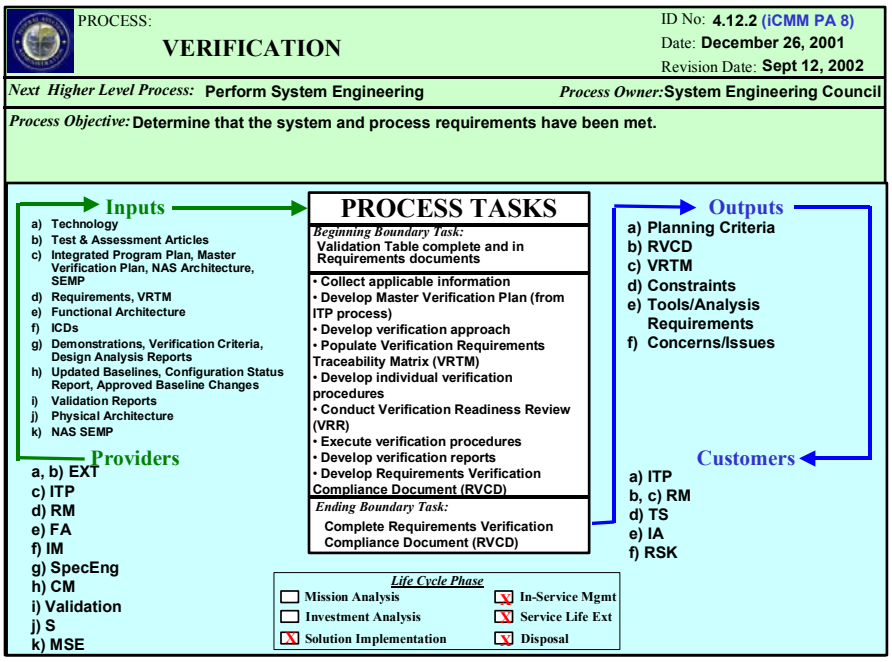


Figure 4.12-7. Verification Process-Based Management Chart

4.12.2.1 Objectives of Verification

The major objectives of the Verification process are to confirm that:

- Intended functions are correctly implemented and that the system is operationally ready and acceptable to the users
- Requirements are satisfied
- Specialty Engineering analyses, including lifecycle, remain valid for the system as implemented

Successful Verification confirms that the development process has provided a system consistent with stakeholder needs and compliant with the system's validated requirements. It is a basic principle to verify all requirements in the system's requirements documents. This principle does not imply that a test is required for every requirement, but it does imply the need to conduct some form of Test and Evaluation (T&E) and/or SE Assessment at an appropriate level to ensure that all requirements are satisfied.

The broad range of product development cycles and levels of product development complexity require that the Verification process be tailored to each project.

The expected outcomes of Verification are the development of:

- MVP (from the Integrated Technical Planning process (Section 4.2))
- VRTM
- Individual T&E and SE Assessment plans
- T&E procedures

- Verification Readiness Reviews (VRR) (if applicable)
- T&E and SE Assessment reports, which detail specific test results and assessments
- RVCD, which provides documentation that the system product conforms to system requirements and includes nonconformance reports

4.12.2.2 Definition of Verification

The accepted definition of verification for this manual and the FAA is:

> *"the evaluation of an implementation [system] to determine that applicable requirements are met." (SAE ARP 4761, 1996)*

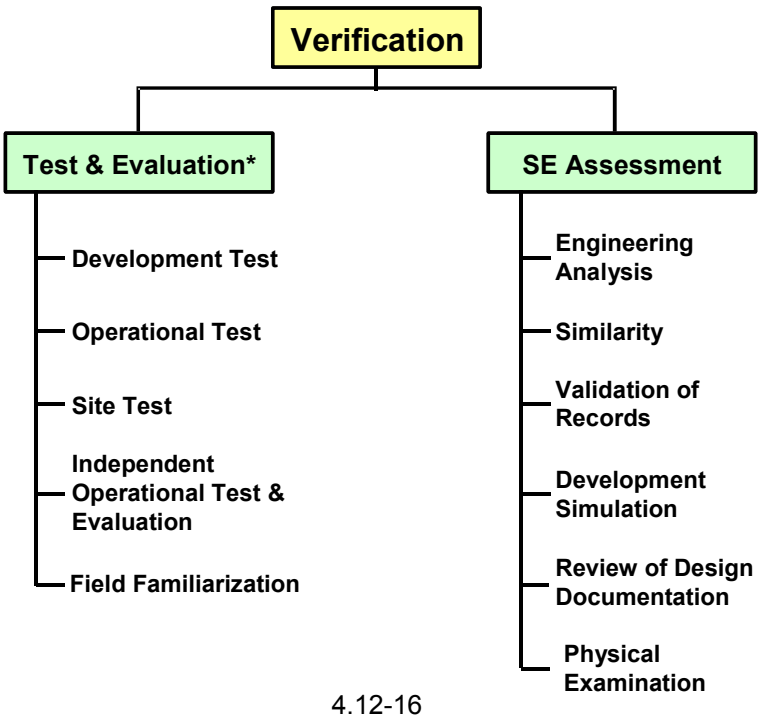
Verification is the composite of all tasks, actions, and activities performed on system elements that are required in order to evaluate the progress and measure the effectiveness of evolving system products and processes in meeting system requirements. There are two basic and complementary methods of Verification: T&E and SE Assessment, as shown in Figure 4.12-8.

4.12.2.2.1 Test and Evaluation Verification

It is recommended that T&E programs be structured to:

- Provide essential information to support decisionmaking
- Provide essential information to assess technical and acquisition risk
- Verify the attainment of technical performance specifications and objectives
- Verify that a system is operationally effective and suitable for its intended use

It is also recommended that T&E objectives for each AMS lifecycle phase be designed to mitigate potential operational risks and to demonstrate system performance appropriate to that phase. Quantitative criteria provide substantive evidence for analysis of hardware, software, and system maturity and readiness to proceed through the acquisition management process.



* For more information, refer to the Test and Evaluation Process Guidelines Document on the FAA AMS Toolset (http://fast.faa.gov).

Figure 4.12-8. Components of Verification

It is recommended that each T&E phase have specific milestones (entrance and exit criteria) that are satisfied before the next T&E phase is entered. Parallel testing is encouraged when it is more efficient and at least as effective as serial testing.

It is highly desirable that system performance be established by test under actual (or simulated) operating conditions; however, these conditions may not be possible until the system is deployed. Problems uncovered at deployment are costly to correct; therefore, a combination of inspection, analysis, and test often is employed during program development to detect problems early, thereby reducing risk and helping to ensure a successful, cost-effective program.

Compliance with each requirement in a specification shall be verified by one or more of the methods described in this manual and as indicated in the VRTM.

T&E methods include:

- **Verification by Demonstration**. This method includes Verification accomplished by operation, adjustment, or reconfiguration of items performing their design functions under specific scenarios. The items may be instrumented and quantitative limits of performance monitored; however, only check sheets are required rather than recordings of actual performance data. This method is used when actual demonstration techniques may be used to verify compliance with a requirement. Observations made by engineers or instrumentation are compared with predetermined responses based on the requirements. An example of this Verification method is the demonstration of installing and uninstalling an aircraft engine in a specified amount of time . Demonstration is often used to verify compliance with requirements in servicing, reliability, maintainability, transportability, and human factors engineering.
- **Verification by Test**. This method is accomplished through systematic exercising of the application item under appropriate conditions, with or without instrumentation, and the collection, analysis, and evaluation of quantitative data.
- **Verification by T&E Analysis**. This method is accomplished by technical or mathematical evaluation, mathematical models or simulation, algorithms, charts, circuit diagrams, and representative data.
- **Verification by Inspection**. This method is accomplished by visually examining the item, reviewing descriptive documentation, and comparing the appropriate characteristics with predetermined standards to determine conformance to requirements without the use of laboratory equipment or procedures. Inspection is generally nondestructive and uses the senses of sight, hearing, smell, touch, and taste; simple physical manipulation; mechanical and electrical gauging and measurement; and other means of investigation. Inspection often verifies the physical design features of a system as well as construction features, workmanship, dimensions, quality, and physical conditions, such as cleanliness, installation, and finishing. Inspection may include reviews of documentation, system descriptions, and other materials to compare the actual system with predetermined standards.

The Test and Evaluation section of the FAST (http://fast.faa.gov/toolsets/index.htm) provides specific guidelines to conduct T&E.

4.12.2.2.2 Verification by System Engineering Assessment

It is recommended that Verification by SE Assessment be conducted to support the development of products, services, and processes necessary to verify that system end-items satisfy their requirements. Verification assessment addresses Verification requirements and criteria for solution alternatives; definition of Verifications to demonstrate proof of concept; and development, qualification, acceptance, pertinent operational, and other testing. The assessment may also consider the requirements and procedures needed to verify critical Verification methods and processes (e.g., Verification of key methods and assumptions and the data used in Verification by analysis).

It is suggested that Verification assessment be initiated when a design concept is established. The Verification assessment is drawn from the MVP and the results of the Validation effort. According to the Integrated Technical Planning process (Section 4.2), the objective of the MVP is to define all Verification activities that demonstrate the system's capability to meet the requirements of its specification. These activities shall be fully integrated to ensure that adequate data is provided at minimum cost within the allotted timeframe. A continuing feedback of Verification data throughout product development, test, and evaluation is necessary to reduce risk and to detect problems early. The goal is to completely verify the system's capability to meet all requirements before production and operational use.

SE Assessment methods include:

- **Verification by Engineering Analysis**. This process includes the techniques of SE analysis, Specialty Engineering, statistic and qualitative analysis, simulations, and modeling. Engineering analysis is used when testing is not feasible, similarity is nonapplicable, and inspection is inadequate.
- **Verification by Similarity**. This process assesses compliance with requirements by reviewing a similar system's test data, configuration, and applications. This method is only used when the systems are similar in design and manufacturing, and the prior system was qualified to equivalent or greater specifications. Great care is taken to ensure that the intended application environment of the emerging system is identical or less rigorous than the environment of the previous system testing.
- **Validation of Records**. This process reviews manufacturing records at end-item acceptance to verify features and requirements of the system.
- **Simulation**. This process verifies design features, system behavior, and performance using simulated models of the system.
- **Review of Design Documentation**. This process uses the disciplined review of design documentation, such as reports and drawings from Acquisition Reviews, Design Reviews (preliminary and critical), and other evaluations.
- **Physical Examination**. This process assesses compliance with requirements by visually inspecting a physical item or configuration according to preestablished criteria.

4.12.2.3 Interfaces With Other System Engineering Processes

Verification has multiple interfaces with other SE elements. These interfaces are shown in Figure 4.12-9 and described in the following paragraphs.

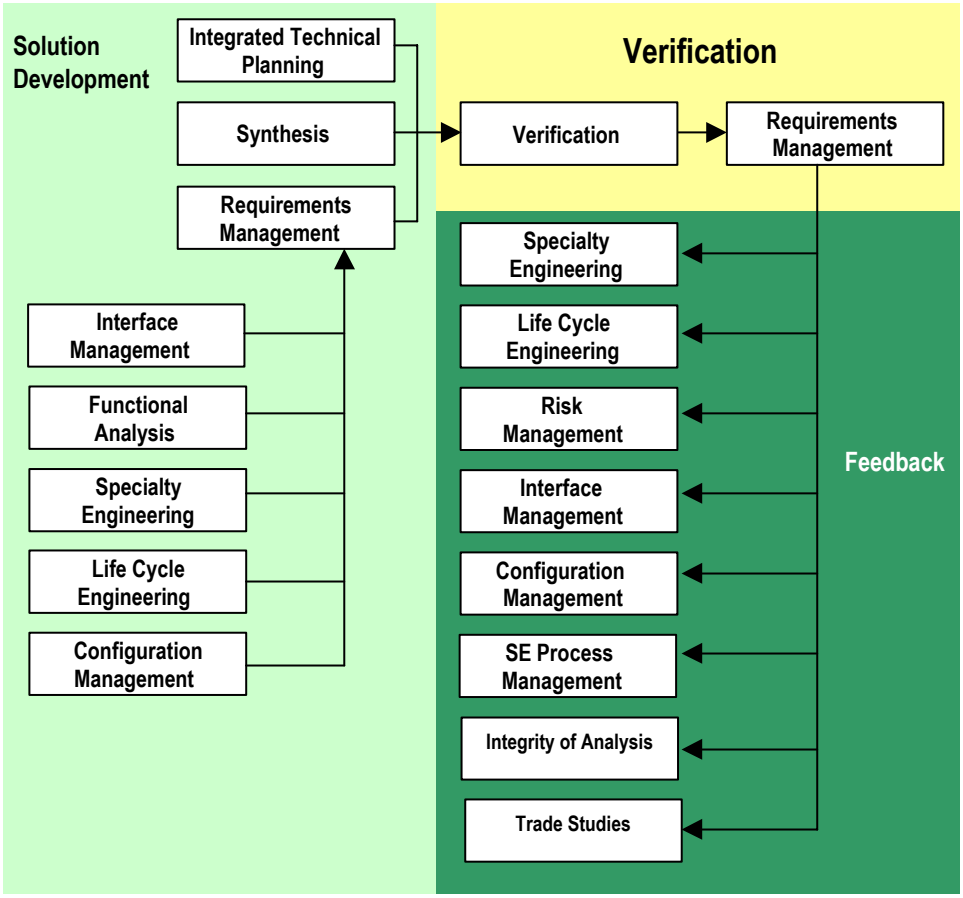


Figure 4.12-9. Verification Interfaces With Other System Engineering Elements

4.12.2.3.1 Requirements Management

Requirements documents are outputs from the Requirements Management process (Section 4.3). These documents include the iRD and fRD, as well as underlying documents, such as customer operational requirements, system and technical requirements, and regulatory, agency, and statutory requirements. These documents also include the MNS and any Verification specification documents. The execution teams manage these documents.

4.12.2.3.2 Synthesis

System, subsystem, component, and procedural designs comprise the outputs of the Synthesis process (Section 4.5). The information contained in these designs and, in some cases, test articles and/or prototypes is required for Verification.

4.12.2.3.3 Integrated Technical Planning

Technical plans are an output of the Integrated Technical Planning process (Section 4.2). They define the program's tailored tasks for a specific program. The IPP lays out the overall program; The MVP comes from the Integrated Technical Planning process but is a separate plan.

4.12.2.3.4 Specialty Engineering

Specialty Engineering (Section 4.8) both feeds and is fed by the Verification process. Specialty Engineering often is a source of requirements and design constraints that require Validation and Verification. In addition, Specialty Engineering analyses often are used to assist in the Verification of requirements as part of assessment. Specialty Engineering DARs are the major outputs of the Specialty Engineering process. These reports document the results of the Specialty Engineering analyses, which may result in the identification and Validation and Verification of requirements. Once Verification is complete, the verified requirements are checked to ensure that the Specialty Engineering DARs reflect the Verification.

4.12.2.3.5 Risk Management

Risk Management (Section 4.10) is another SE element that both feeds and is fed by the Verification process. Risk Management is able to drive the Verification of high-risk requirements. In addition, all requirements that fail to meet verification criteria are considered a risk to the program. These requirements become inputs to the Risk Management process for mitigation.

4.12.2.3.6 Interface Management

Results of the Interface Management process (Section 4.7) provide a deeper understanding of the underlying physical and functional interfaces of the system requirements. The interface documentation includes the system-level interface definitions.

4.12.2.3.6.1 Lifecycle Engineering

Lifecycle Engineering (Section 4.13) is another SE element that both feeds and is fed by the Verification process. This element provides supportability, deployment and transition, real estate and disposal requirements, and design constraints. These requirements and design constraints undergo the Verification process to ensure compliance.

4.12.2.4 Inputs to Verification

There are four major input categories to Verification:

- Technology
- Technical Plans
  - IPP
  - MVP
  - Program SEMP
  - NAS Architecture
- Requirements
  - Requirements documents and associated Validation Reports
  - VRTM templates populated with Requirements
- Design information and Test and Assessment articles

- Functional Architecture
- Physical Architecture
- Interface Control Documents (ICD)
- Demonstrations
- Verification Criteria
- DARs
- Updated Baselines
- Configuration Status Report
- Approved Baseline Changes

4.12.2.4.1 Technology

State-of-the-art Technology constrains the means of Verification. Therefore, it is critical that this factor be considered in the development of the Verification approach.

4.12.2.4.2 Technical Plans

These plans, developed via the Integrated Technical Planning process (Section 4.2), detail the overall vision for executing the program, including the timing and sequence of Verification. The plans that need to be collected to properly conduct Verification include the IPP, the MVP, and program SEMP. The NAS Architecture is also a valuable input in that it defines the FAA framework in which the system being verified eventually operates.

4.12.2.4.3 Requirements

Requirements documents are an output of the Requirements Management process (Section 4.3). These documents include customer operational requirements, as well as regulatory agency and statutory requirements. With Validation Reports (and associated Validation Tables) and Verification specifications included, these documents are the primary source of information for the Verification process. Phase-specific implementation teams maintain requirements documents. It is recommended that these documents include the most up-to-date information from interfaces, Functional Analyses, Specialty Engineering analyses, and system configuration.

4.12.2.4.4 Design Information and Test and Assessment Articles

This input is essential to understanding the product configuration. (Configuration Management (Section 4.11) supplies a complete description of this process.) To develop the MVP and the individual test plans, the system engineer needs any available design information, including Physical Architectures, drawings, interface documents, system design specifications, functional specifications, product specifications, and test equipment designs. This information also includes Specialty Engineering DARs used for the assessment. In addition, Functional Architectures and their associated analyses need to be available. The results of the Functional Analyses provide a deeper understanding of the underlying functions and reasons for the Requirements. ICDs, if they exist at the time of Verification, are also required. These documents provide detailed information on the interfaces involved in system operation. Part of the Validation and Verification of a system is the assurance that the Requirements for these

interfaces are correct and satisfied. The Test and Assessment Articles are the constituent pieces of the system, or the system in its entirety, on which Verification is performed.

4.12.2.5 The Verification Process

Verification is accomplished through a combination of T&E and SE Assessment. The general Verification process tasks are grouped into three distinct phases: planning, Verification activities, and documentation. Planning and documentation are common to both T&E and SE Assessment. Planning includes determination of the resources required, sequence and timing of activities, data and documentation to be produced, and establishment of the assessment criteria. The results of the planning effort are documented in the MVP. The documentation phase includes those tasks taken to ensure that evidence of completion is recorded and collated. The activity phase includes the processes or tasks in which the actual Verification methods are employed, whether they are T&E or SE Assessment. These processes are described below.

4.12.2.5.1 Process for Verification by Test and Evaluation

Specific guidelines for planning and conducting a T&E process are included in the FAA AMS Test and Evaluation Process Guidelines located under Test and Evaluation in the index of the FAST (http://fast.faa.gov/toolsets/index.htm).

4.12.2.5.2 Process for Verification by System Engineering Assessment

Verification by the SE Assessment is accomplished simultaneously and is fully coordinated with other SE processes—Integrated Technical Planning (Section 4.2); Requirements Management (Section 4.3); Interface Management (Section 4.7); Specialty Engineering (Section 4.8); and Risk Management (Section 4.10)—and test functions to ensure project costs, schedules, and risk implications are managed efficiently. The program plan for the Validation and Verification process is documented in specific detail in the MVP and in general in the IPP. Figure 4.12-10 depicts the overall Verification process.

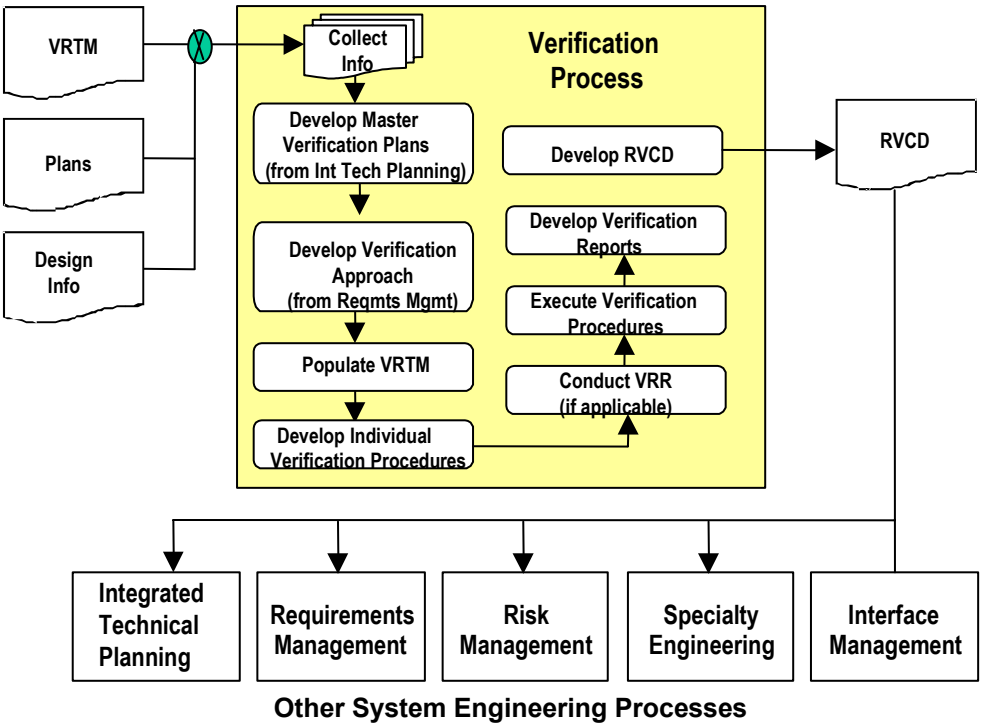


Figure 4.12-10. General Verification Process and Outputs

4.12.2.5.2.1 Verification Process Purpose

Through assessment of the system product, the Verification process demonstrates that system behavior and characteristics comply with the specified Requirements. Verification provides the information required to effect the remedial actions necessary to correct nonconformance in the realized system or the processes that act on it.

4.12.2.5.2.2 Verification Process Tasks

The recommended process tasks for conducting Verification of Requirements by SE Assessment are shown in Figure 4.12-7 and are described in the following paragraphs.

4.12.2.5.2.2.1 Task 1: Collect Applicable Information

At minimum, the inputs discussed in Paragraph 4.12.2.4 shall be collected and reviewed for impacts on the Verification process. For instance, the DARs generated by Specialty Engineering (Section 4.8) may have identified special Verification procedures or needs.

4.12.2.5.2.2.2 Task 2: Obtain Master Verification Plan From Integrated Technical Planning or Develop It Now

As the Verification approach is refined, the facilities, budget, schedules, personnel, test articles, instrumentation, and data necessary to accomplish the Verification events are also identified, coordinated, and approved with the appropriate decision authorities, resulting in an approved Verification plan for the program. This strategy and overall plan for the Verification process is documented in the MVP, which is delivered from the Integrated Technical Planning process (Section 4.2) to “Task 7: Execute Verification Procedures” (Paragraph 4.12.2.5.2.2.7). The MVP

is required to provide the content and depth of detail necessary for understanding the Verification activities. Each major activity is defined and described in detail. The MVP covers all qualification, acceptance, predevelopment, operational, and disposal Verification activities for hardware, software, and procedures. The MVP provides a general schedule and sequence of events for major Verification activities. It also describes test hardware and software, support equipment, and facilities required to support Verification activities. The MVP is developed by design, system, and test engineers with a thorough understanding of the requirements document, segment requirements and specifications, and Validation Table.

It is recommended that the following activities be completed during the planning stage:

- Identify the system and system configuration, including definition of test equipment and telemetry, facilities, and support equipment
- Identify and collate all Requirements appropriate to the (level of) Verification
- Define the specific Verification method employed for each Requirement
- Define the criteria used to evaluate the evidence from each Verification for each Requirement

4.12.2.5.2.2.3 Task 3: Develop Verification Approach

Simply put, the Verification approach is how the Requirements are going to be verified. This approach is developed in Requirements Management (Section 4.3) and documented in the VRTM. This task includes the activities of receiving, updating, analyzing, decomposing, and summarizing Requirements to ensure that they are economically and efficiently measurable and are able to be appropriately distributed for Verification planning. The purpose of the Develop Verification Approach activity is to determine and document the Verification approach to ensure that the product is compliant with the identified Requirements.

In this step, the Verification specification (from Requirements Management) is used to develop a Verification approach for each Requirement documented in the Validation Table. The Validation Table is further refined into a VRTM. The VRTM is the heart of the Verification process. The strategy or method used to verify each Requirement is specified in a Verification Requirement, and the Verification Requirements are listed in the VRTM. The VRTM defines how each Requirement (functional, performance, design, etc.) is to be verified, the stage in which the Verification is to occur, and the applicable Verification levels. The VRTM essentially establishes the basis for the Verification program. SE and the Verification team develop the VRTM together. The T&E and the SE Assessment methods available for use are discussed in detail in Paragraphs 4.12.2.2.1 and 4.12.2.2.2. Table 4.12-2 is an example VRTM. Specific guidelines for the VRTM are included in the Test and Evaluation section of the FAST (http://fast.faa.gov/toolsets/index.htm).

Table 4.12-2. Sample Verification Requirements Traceability Matrix

Section 3 Requirements Paragraph Reference for Specification SCN (Paragraph No./Title)	Requirement Description	Verification Method (Test, Demonstration, Analysis, Inspection, Engineering Analysis, Similarity, Validation of Records, Simulation, Documentation)	Verification Plan (Indicate which plan describes the Verification of the requirement)	Remarks
3.1.1.1 Aircraft I.D.		T = Test		
3.1.1.2		D = Demonstration		
3.1.1.3		A = Analysis		
3.2.1.1 System Alignment		I = Inspection		
3.3.1.1 Transmit Time		EA = Engineering Analysis		
3.3.1.2 Receive Time		SY = Similarity		
3.3.1.3 Process Time		VR = Validation of Records		
3.3.1.4 Display Time		SM = Simulation		
3.3.1.5 System Check		DC = Documentation		

4.12.2.5.2.2.4 Task 4: Populate the Verification Requirements Traceability Matrix

Verification is performed at all levels in a system. Each Requirement is verified either by test, SE Assessment, or both, as appropriate. As mentioned earlier, the strategy or method used to verify each Requirement is specified in a Verification Requirement, and the Verification Requirements are documented in the VRTM. It is recommended that a description of the test or SE Assessment and the criteria used to determine conformance and disposition of each Verification Requirement be included in the VRTM.

4.12.2.5.2.2.5 Task 5: Develop Individual Verification Procedures

This process is the detailed development of Verification procedures and resources that achieve specified Verification objectives using approved agency and regulatory procedures. Specific guidelines on content and format are included in Sections 6 and 7.1 of the FAST and Test and Evaluation Guidelines (http://fast.faa.gov/toolsets/index.htm).

The product Verification procedures consist of step-by-step directions to conduct the actual product Verification at any level. Traceability to all Requirements in the VRTM shall be shown as an integral part of these procedures. The procedure is tailored to the Verification activity that is to be performed to satisfy Requirements and may be a test, SE Assessment, or a combination of both. The as-run and certified copy of the procedure is maintained as part of the project's archives as test or SE Assessment plans.

All Verification procedures for both hardware and software include development of test plans, procedures, and test cases. The process includes performing timing and sizing analysis Verification at the subsystem and system levels. The results of these analyses are maintained in the test or SE Assessment plans.

The process also performs abnormal and erroneous condition testing at the subsystem and system levels. The process includes the use of regression test procedures for hardware and software integration, subsystem test, and integration and system test, including the use of a core test process, if planned.

The Verification process incorporates any commercial-off-the-shelf (COTS) software or hardware in the system integration and test planning.

4.12.2.5.2.2.6 Task 6: Conduct Verification Readiness Review

A VRR or equivalent is held before each major Verification or groups of smaller Verifications with common elements. The VRR is conducted to ensure that all SE considerations are satisfied and that the readiness of all support, test, and operational systems is in order to perform the Verification process. The VRR includes a detailed review of the status of the facilities, ground support equipment, Verification design, software, procedures, and Verification Requirements. In addition, Verification activities and schedules are outlined, and organizational/personal responsibilities are identified. Emphasis is on ensuring that all Verification Requirements identified for each Verification method or technique are included in the Verification design and procedures.

A key feature of the Verification approach is the non-advocate aspect (i.e., it is a principle of the Verification process that the person or group performing the design not execute the Verification activities). The same principle applies to planning and conducting the Verification design itself. The VRR is conducted to ensure that Verification activities are planned adequately and that risks are controlled. It is recommended that the VRR be chaired by senior personnel not associated with the program but who possess some expertise in the systems and operations under evaluation. The program implementation teams manage the VRR.

4.12.2.5.2.2.7 Task 7: Execute Verification Procedures

This task is the actual product of the Verification process (i.e., the conduct of tests or SE Assessment). The process of product Verification confirms through documented evidence of Verification activities that production-representative hardware and software are in compliance with functional, performance, and design requirements.

The Verification team is responsible for performing product Verification, which consists of preparation for product Verification, execution of product Verification activities, and product post-verification and documentation. Specific guidelines for the test process are found in the Test and Evaluation Guidelines in the FAST (http://fast.faa.gov/). When performing test Verification, the Verification team shall consult this document for specific instructions. Specialty Engineering (Section 4.8) supplies specific guidelines on conducting system (specialty) engineering assessments.

Responsibilities of the Verification team during the preparation phase of a Verification program using testing and demonstration may include:

- Design, fabrication, and/or preparation of the Verification setup

- Verification facility
- Verification fixture and/or stations
- Data acquisition, reduction, and archive system
- Verification control system
- Instrumentation system
- Design and fabrication of Verification article hardware/software
- Conduct of make-or-buy analyses for Verification setup hardware and software
- Coordination of Verification article delivery
- Coordination of Verification setup hardware/software delivery
- Coordination of support equipment and special Verification
- Preparation of Verification safety, hazard, and environmental compliance plans
- Assembly and installation of the Verification article, fixture, and setup
- Implementation of serial numbered component installation/removal records
- Installation of Verification instrumentation
- Preparation of instrumentation installation drawings
- Implementation of instrumentation installation/removal records
- Management of Verification configuration control
- Verification articles
- Instrumentation and measurements
- Data acquisition and reduction system
- Verification support software
- Checkout and maintenance of the Verification setup hardware and software
- Coordination of Verification article configuration buyoff and/or conformity approval inspections
- Conduct of preverification conference or VRR (or equivalent)
- Management and status reporting of Verification preparation activities

During the preparation phase, quality-control members of the Verification team establish/verify conformity of Verification articles, establish/verify conformity of the Verification methods, and check/verify systems and operations.

Responsibilities of the Verification team during the product Verification execution may include:

- Maintenance of detailed Verification notes/logs, including all deviation from the MVP
- Management of Verification configuration control
- Verification facility
- Verification fixture and/or stations

- Verification article
- Instrumentation and measurements (if required)
- Data acquisition and reduction system (if required)
- Verification support software
- Coordination of Verification article configuration and/or conformity approval inspections (if required)
- Coordination of Verification witnessing
- Checkout and maintenance of the Verification setup hardware and software
- Management of calibrated equipment (if required)
- Execution of Verification in accordance with approved MVP
- Validation, collection, reduction, archive, and delivery of Verification data
- Management and status reporting of Verification activities
- Conduct of post-verification inspections
- Identification of readiness criteria for formal and informal system and subsystem test
- Conduct of unit tests on software code changes before they are incorporated; review of software code changes for correctness and the avoidance of undesired impact on other software and system variables and components

4.12.2.5.2.2.8 Task 8: Develop Verification Reports

When product Verification is complete, the Verification team is responsible for conducting a post-verification review and preparing a report to disseminate the results. The purpose of the Verification report is to determine compliance with the Verification Requirements.

Documentation of product Verification is completed by the Verification team and distributed to all interested parties. This documentation includes reports that detail the Verification results, including nonconformances, failure analyses, and other findings.

It is recommended that a Verification report be provided for each test and SE Assessment and, at minimum, for each major Verification activity. If testing occurs over long periods of time or is separated by other activities, Verification reports may be required for each individual Verification activity. It is recommended that Verification reports be completed within a few weeks following a test and include evidence of compliance with the Verification Requirements for which it was conducted. The Verification report documents the steps that were taken to ensure that the Verification process was followed and that the Verification decisions were sound.

Guidelines for developing and formatting specific types of T&E reports are specified in the Test and Evaluation section (specifically, Section 6) of the FAST (http://fast.faa.gov). For Verification by SE Assessment, it is recommended that the Verification report be documented as a DAR, as defined in Specialty Engineering (Section 4.8).

4.12.2.5.2.2.9 Task 9: Develop Requirements Verification Compliance Document

The RVCD provides the evidence of compliance for each Requirement at all levels and to each VRTM Requirement. The flow down from the requirements documents to the VRTM completes the full Requirements traceability. Compliance with all the Requirements ensures that the system-level Requirement have been met.

The RVCD defines, for each Requirement, the methods of Verification and corresponding compliance information. The results of the Verification activity, including evidence of completion, are recorded and documented in the RVCD. The RVCD contains information regarding the results of each Verification activity and a description and disposition of conformance, nonconformance, conclusions, and recommendations. The compliance information provides either the actual data or a reference to the location of the actual data that shows compliance with the Requirement. The document also includes a section that details any noncompliance; this section specifies appropriate reverification procedures. The RVCD is an input to the Requirements Management process (Section 4.3); decisions regarding what to do with noncompliant Requirements are made during this process.

The specific compliance information may reference a test or SE Assessment report, automated test programs, or any other data generated in the Verification process. These inputs usually occur over a lengthy period of time and may be continuous on large programs.

Up-to-date information shall be maintained in the compliance document (RVCD) for the VRR for elements already verified. The RVCD is not baselined because it is updated throughout the program's lifecycle.

The purpose of this process is to analyze the data and results from "Task 7: Execute Verification Procedures" (Paragraph 4.12.2.5.2.2.7). If the Requirements have not been satisfied, coordination shall occur (with customer/stakeholder involvement, as necessary) to determine the impacts on the Requirements, design, and Verification approach. As a result of the impact analysis, compliance reports are generated, and the appropriate action(s) regarding the noncompliance are taken. This activity is iterative and shall be performed each time "Task 7: Execute Verification Procedures" is initiated. It is recommended that compliance reports include Requirements' identification information, compliance status, and Verification approach information.

The Validation and Verification process is completed when the information in the RVCD documents that all identified Requirements have been addressed by Verification activities and the product is compliant. When product Verification is completed, SE is responsible for completing/updating the RVCD.

4.12.2.6 Disposal of Resources

This process obtains formal direction or consent for shipment, contract transfer, sale, scrap, donation, or abandonment of Verification activity resources. Disposition ensures the safe deactivation and disposal of all system products and processes and that Verification necessary to establish compliance with disposal requirements are finished.

Once product Verification is completed, accepted, and documented by SE and the Verification team, the Verification team is responsible for identifying unused, excess, or obsolete Verification resources. Depending upon resource ownership, required disposal documentation is submitted, and resource disposal is accomplished. All resource disposal actions are documented and filed or archived, as required.

4.12.3 Outputs of Validation and Verification

The major outcomes of the Validation and Verification process are:

- Planning criteria for the Integrated Planning (Section 4.2) process to develop and complete the MVP (as well as the IPP and program's SEMP)
- Constraints that may affect Trade Studies activities (Section 4.6)
- Concerns/issues (Appendix D) for the Risk Management process (Section 4.10) to analyze
- Outputs unique to the Validation process
  - Validated Need
  - Validation Table documented in the Validation Report
- Outputs unique to the Verification process
  - VRTM populated with Verification results
  - RVCD
  - Tools/Analysis Requirements for conducting planned Verification approach(es)
  - T&E and SE Assessment plans (internal to Validation and Verification)
  - VRRs (internal to Validation and Verification)
  - Verification documentation, including Verification reports (internal to Validation and Verification)

4.12.4 Validation and Verification Tools

There are several dedicated tools available to assist in managing the relationship between requirements, their validity, and their verification method. The selection of tool(s) shall ensure that the data is transportable and able to be integrated with other related SE results. A list of tools that may be used to facilitate this process is available on the International Council on System Engineering Web site (www.incose.org). Smaller projects may successfully manage these relationships with a simple spreadsheet or database application instead of a dedicated tool. (The Validation Table (Table 4.12-1) and the VRTM (Table 4.12-2) further illustrate this topic.)

4.12.5 Unique Tailoring Guidance

The Verification team of a specific project may select the particular means of Verification for that project. For small projects, the project team may perform the function of the Verification team. The project team may perform both the SE and the Verification team functions. Regardless of the scope of the project and depending on the required or desired visibility into the Validation and Verification process, the project team may consider merging the Validation table, VRTM, and compliance data into one consolidated table. Such a consolidated view may be readily produced with any of the following: a simple spreadsheet application (e.g., Microsoft Excel), a robust requirements traceability application (e.g., DOORS), or a relational database application (e.g., Oracle or Microsoft Access). These tools or similar tools may be used to produce this macro-level view with the capability to filter to some lesser view as needed. Table 4.12-3 illustrates this overarching consolidation view.

925 **Table 4.12-3. Sample Validation and Verification Traceability and Compliance Table**

Validation								Verification Traceability						Verification Compliance			
Source Doc (*)	PUI	Reqmt	Valid (Y/N)	Valid Source(s)	Location in Source	Corr Action	Actionee	Method				Level	Verif Reqmts Traceability	Verif Task	Plan Ref	Report Ref	Verif Status
								Test	Anal	Demo	Exam						

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4.12.6 References

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